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DETERMINATION OF MAINTENANCE EXPENDITURE LIMITS
FOR DEPOT REPARABLE ITEMS

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U.S. ARMY MATERIEL SYSTEMS ANALYSIS ACTIVITY
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The repair at depot of items grouped under one Procurement Request Order Number (PRON) is only authorized if the average per item repair cost does not exceed a predetermined maximum expenditure limit called the Maintenance Expenditure Limit (MEL) or the item manager that initiated the PRON approves a waiver of the MEL. If the MEL for a PRON is set too high, there is a possibility that failed items will be repaired when it would be more cost effective to the Army to dispose of them and replace with newly acquired items. Conversely, if the MEL is set too low, there is a possibility that failed items that should be

repaired will be disposed of. This calls for a unique, optimal MEL for each PRON At the present time the MEL for all depot reparable items is set at 100% of the item price as found in the Army Master Data File (AMDF) or the Commodity Command Standard System (CCSS). This value is compared to the estimated or actual in-depot repair costs (Unit Maintenance Total Cost - UTOT). This MEL is recognized as not being optimal. In this report, a method is developed for establishing an optimal MEL for a PRON and a worksheet for performing the MEL calculations. The method requires that a current item price be used and incorporates all the relevant costs that should be included in a buy or repair decision to include a factor for any impact on readiness. The calculation using the worksheet is simple to understand and use, since only seven data values are required. Default data values are provided for quick MEL estimates. The calculation will be done manually until the procedure is automated on CCSS. The report also provides a procedure for exempting items from a MEL and request for waiver and for updating the MEL prior to the execution of the PRON.

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Chapter 1. INTRODUCTION

1.1. Requirement for Maintenance.

a. To fulfill its mission of deterring war, the Army requires a great variety and large quantity of the most effective equipment that the nation can afford. Having these tools of war available when needed is the essence of readiness. To maintain maximum readiness, unserviceable (deteriorated and failed) equipment must be returned to a serviceable condition or must be replaced.

b. Three different actions can be taken on unserviceable equipment. It can undergo corrective maintenance; i.e., returned to some level of serviceability through a repair, overhaul, or rebuild program; it can be discarded and replaced with identical new equipment; or it can be discarded and replaced with newer, upgraded equipment. The term repair will be used in this report to mean any corrective maintenance action.

c. The Army has the ability to repair unserviceable equipment or to procure new equipment. Due to limited resources (funds and facilities), priorities must be established on competing maintenance requirements. These entail economic decisions requiring quantitative methods.

d. Two such quantitative methods are the Level of Repair Analysis (LORA) and the Maintenance Expenditure Limit (MEL). The LORA is performed in the design phase and analyzes the total life cycle costs involved in repairing versus replacing an item or component. Based on the least cost, an item is classified as either a reparable or non-reparable (throwaway). The analysis also indicates at which repair echelon the various maintenance actions should be performed. The LORA is used throughout the development phase of a system. The MEL is a decision tool that is used only on fielded equipment that has failed. For each Procurement Request Order Number (PRON), MEL establishes a dollar limit on the maintenance that may be performed at a depot. LORA and MEL are discussed in depth in Chapter 3 and in Appendix B.

e. The MEL provides the item manager and the Major Subordinate Command (MSC) a method of determining whether an unserviceable item should be repaired or replaced. By means of the MEL, the item manager specifies to the depot the maximum expenditure that he has determined to be economically defensible to repair a failed item. If repair is expected to cost more than the specified MEL, the repair decision must be reviewed; if repair is expected to cost less than the MEL, the repair will be accomplished without further review.

f. The MEL concept is used at all echelons of maintenance. However, because the capability for performing repairs is different at each echelon, the MEL values are different for depot, field, or contractor repair.

1.2. Purpose.

For the depot level maintenance program, provide a rational basis for the repair versus replace decision process. This decision process will enable the US Army Materiel Command (AMC) to spend maintenance dollars more wisely.

1.3. Objectives.

This study has two objectives: to develop an algorithm for calculating MEL values to be used in depot level repair programs, and to determine default values for the parameters used in the calculation.

1.4. Limits and Scope.

a. This study investigates aspects of the Army's depot level maintenance program and the depot/MSC interactions that result. The MEL developed will be used in economic justifications of existing repair programs. It will not be used to establish the reparable status and repair level of newly introduced items in the Army inventory. This is done by LORA.

b. This study does not address maintenance at other than depot level. MEL for field use may be derived from the computations developed in this work but are not discussed or developed here.

c. The developed algorithm must be simple enough to be implemented on a routine basis utilizing readily available data.

d. The algorithm must be implementable on an existing automated system such as the Commodity Command Standard System (CCSS).

e. The algorithm must be generic in the sense that it applies to all Army commodities.

1.5. Methodology.

A mathematical formula is developed for computing individual MEL values that incorporates all the direct and associated costs of item acquisition and depot repair.

Chapter 2. MAINTENANCE

2.1. Readiness Implications.

a. To maintain a high degree of readiness, a maintenance program is essential to keep equipment operational and combat ready. Maintenance of equipment is a large expense to the equipment owner. Determining when to repair, to what degree, and when to replace is a problem for both the DOD and industry. The motives are different, however. In industry the motive is profit, whereas for the DOD it is readiness.

b. When an Army item fails, readiness is often affected and steps are taken to repair the item or to replace it through acquisition. Policy directs that, where possible, repair should be the first choice, then replacement if repair is not authorized or cost effective. When a failure occurs, it is usually a major item that is made inoperable but the failure is due to a component--a secondary item that has to be repaired or replaced.

2.2. Maintenance Characteristics.

a. Items can usually be obtained more quickly from a maintenance program than through an acquisition action. This maintenance program essentially provides an additional source of supply.

b. For many items, maintenance is cheaper than acquisition. For example, the Army acquires a fixed number of items according to an initial issue schedule. Once this quantity has been acquired, the contract is closed. If at a later date further acquisitions are authorized, because of the small quantities, the price will be higher. This forces a decision in favor of maintenance at failure.

c. Another condition that favors the maintenance decision is that maintenance funds are more readily available than acquisition funds.

d. A negative aspect of maintenance is that the worth of a repaired item, in terms of its reliability and efficiency, is believed to be lower than that of a new item. The perception by users is that the Mean Time Between Failure (MTBF) on repaired items has decreased and failure is more difficult to predict. However, the few studies that have investigated the worth of a repaired item compared to a new item have not produced factors that could be used in such a comparison.

e. Another negative characteristic of maintenance is that continued repair can contribute to the technological obsolescence of equipment. Continued repair tends to keep items in the supply system longer. The Army usually keeps and provides technologically obsolescent items to lower priority units when new items are introduced. If the National Guard trains on old equipment which is not compatible with that issued to active units under mobilization, retraining will be necessary and readiness will have suffered.

2.3. Depot Maintenance.

a. Current Army doctrine provides for three basic levels of maintenance: Unit, Intermediate, and Depot. Unit level maintenance is characterized by quick turnaround repair by replacement, minor repairs, and scheduled services. Intermediate level maintenance, which encompasses Direct Support (DS) and General Support (GS), includes repair of assemblies, components, and modules. The highest level of maintenance is performed at depots and includes inspection, testing, modification, calibration, overhaul, and fabrication. Maintenance that is beyond the scope or capacity of the intermediate level is performed at depots.

b. The Army depot maintenance program has a five year planning horizon as part of the Planning, Programming, Budgeting, and Execution System (PPBES). This program is gradually firmed up and is eventually scheduled and executed by means of PRONs.

c. Unserviceable items are accumulated at a depot until an item manager prepares a PRON for their repair. This enables DESCOM to schedule the actual repair program.

d. As items undergo a repair program, maintenance data are gathered. Two important parameters gathered are the average price to repair and the number of additional items that must be input to a repair program to insure that the required quantity will be returned to the supply system.

e. Items for which there is a repair history are repaired at a fixed price. The fixed price is based on the cost to repair the item in the previous year plus or minus a factor for productivity gains and inflation. This fixed price is called Unit Maintenance Total Cost (UTOT).

f. The price for depot level repair of items that do not have a repair history is negotiated between DESCOM and the MSC; the price of repairing similar items is used as a reference point.

Chapter 3. MAINTENANCE EXPENDITURE LIMITS

3.1. Definition.

a. The MEL for an item is the maximum amount that an MSC authorizes a depot to spend to return an average item to a completely serviceable condition. The serviceable condition is defined by a Technical Manual or Depot Maintenance Work Requirement (DMWR). The MEL applies each time an item requires repair and can only be exceeded if the items are exempt from MEL or if the MSC grants a waiver to the MEL.

b. The expenditure limit can be expressed as both a percentage and as a dollar value. When expressed as a percentage, it is called MEL percentage; when expressed as a dollar value, it is called MEL value or often just MEL. The dollar value is determined by multiplying the decimal MEL percentage by the Current Unit Replacement Price (CURP) for that item. This process produces a unique MEL value for tnat item.

c. Field Manual (FM) 29-23 [7]* expresses the MEL concept as follows:

"Before repairing an unserviceable item, economic reparability must be determined. Factors considered are the cost of replacing the item as compared to the cost or repairs. Also considered is the value, in terms of service life, that will be restored to the item if it is repaired. When repair costs exceed maximum expenditure limits, cannibalization or disposal of the unserviceable item is undertaken, unless necessity dictates otherwise. In some cases, the criticality of the item and the difficulty to replace it requires repair regardless of cost."

d. Department of Defense Instruction (DODI) 7220.21 [5] defines economic repair as:

"A repair the cost of which is less than the estimated remaining useful life of the materiel at a point in time based on life expectancy, acquisition or replacement cost, and other relevant factors."

The estimated remaining useful life is difficult to establish in most cases and, therefore, a fraction of the CURP is used.

e. The units inducted to depot for a repair program are in various conditions (i.e., states of disrepair). Therefore, as the repair program proceeds, the repair cost for some units will exceed the MEL, while for others will fall below the MEL. The MEL is exceeded when the average repair cost for the units repaired so far exceeds the MEL and the depot forecasts that the units on that PRON that are yet to be repaired will also, on the average, exceed the MEL. The MEL determination is made by PRON, not by individual items.

f. General guidance on the use of MEL for depot level repairs is found in DARCOM (AMC) Regulation 750-28 [4] and in Army Regulation (AR) 750-1 [2].

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*Numbers in brackets [] refer to references in Appendix A.

3.2. Purpose of MEL.

A MEL ensures that only repairs that benefit the Army will be performed. The cost of the repair is an important factor but it must be tempered by readiness implications and the economics of phasing out and upgrading an item or a system.

3.3. The Origins of MEL.

For many years the maximum MEL, as a percentage of CURP, was arbitrarily set at 65%. As a result of a Department of Defense Inspector General's audit [3] in 1983, the maximum MEL was set at 100% until a method of determining an optimal MEL could be developed. Also, the Department of the Army (DA) determined that any arbitrarily set MEL is suspect and that a quantitative means must be developed to establish optimal MEL for Army items.

3.4. MEL in Other Services and Industry.

a. A Maintenance Expenditure Limit is used by all the services. Industry also uses an equivalent maintenance decision criterion. The MEL used by other services in 1983 is shown in Table 1 and by selected industries in Table 2. At the present time all the services use a maximum MEL of 100%.

b. Repair Policies in Other Services. The following discussion refers to Table 1. Six organizations were contacted to determine how MEL is used.

(1) Naval Supply Command (NAVSUP). The depot must coordinate with the item manager if repair cost is over 100% of standard price. If a waiver is necessary, it must be made in conjunction with the Technical Command.

(2) Ships Parts Control Center (SPCC). The Item Manager (IM) makes the initial decision on depot level repair (DLR). Secondary items that cost more than 75% of standard price to repair are reviewed annually. A panel may remove an item's depot level reparable status. Once the item is in the repair shop, it is not washed out until the repair cost exceeds 100% of standard price.

(3) Portsmouth Naval Shipyard. Production equipment has no formal MEL but the use of a 60% "MEL" is typical. Replacement items are usually much more modern and improved. The Defense Industrial Production Equipment Center (DIPEC) controls all disposal actions.

(4) US Marines. The use of MEL is very similar to Army procedures using 65% MEL. Waivers are granted after an investigation, usually because of inability to replace essential items.

(5) US Air Force. The item manager makes the initial decision but it is subject to review by the Air Force Logistics Center (AFLC). He is informed if projected repair cost exceeds 75% of standard price. Waivers are usually granted because items cannot be procured or overly long lead times are expected.

(6) Canadian Armed Forces. If repair cost exceeds 60% of the item cost, a review of the item is made. Waivers are granted for items that cannot be replaced.

TABLE 1. MEL Policy in Other Services

SERVICE	MATERIEL	MEL GUIDANCE	MAXIMUM	WAIVER POLICY
Navy				
NAVSUP	End Items	75%	100%	If no acquisition source or intolerable lead times.
SPCC	Secondary Items	75%	100%	IM decision with DLR status review annually.
Portsmouth Naval Shipyard	Industrial Equipment	60%	75%	Life expectancy after repair vs replacement item (DIPEC approval).
Marines	Major Items	65%	-	Investigate circumstances, usually inability to replace item.
Air Force	All Items	75%	-	IM decision subject to review by AFLC.
Canadian Forces	Weapon Systems	60%	-	Unreplaceable items may be overhauled regardless of cost.

Extracted from reference [14].

c. Repair policies in industry. The following discussion refers to the entries in Table 2.

(1) American Airlines. A 60% MEL is used for in-house and contract work. Waivers are granted based on personal judgments and review boards. Each category of materiel has different policies.

(2) Delta Airlines. An overhauled engine is considered to be as good as a new one. A 90% limit is set to offset the value of the manufacturer's warranty. Maintenance floats are used to avoid down time. Less valuable components have lower MELs.

(3) Overnight Trucking. Trucks travel 200,000 miles per year. They receive an "in-frame overhaul" (engine overhauled without removing from the

frame) every 325,000 miles or when oil consumption becomes excessive. Their goal is to sell the truck at 675,000 miles because older trucks cause expensive time delays.

(4) Safeway Trucking. Average trip is 240 miles. Trucks are used for about 12 years. A condition evaluation is made on each truck in lieu of formal policy. Less is spent on older trucks. After two "in-frame overhauls," an "out-of-frame overhaul" (engine removed from the frame) is performed. Sometimes the cab and body are replaced while the running gear continues to be used.

(5) US Postal Service. The maintenance supervisor consults a table using age/mileage and acquisition cost. Overhaul must produce at least one more year of service. Waivers are granted when replacement items are not available.

TABLE 2. MEL Policy in Selected Industries

COMPANY	FUNCTION	TYPE OF EQUIPMENT	MEL GUIDANCE	WAIVER POLICY
American Airlines	Air Passenger Carrier	Automotive & Plant Equipment	60%	Return on investment - useful life analysis. Review levels for expenditures.
Delta Airlines	Air Passenger Carrier	Aircraft Components	60-90%	Higher cost items have higher MEL. Consider urgency and supplier responsiveness. If repair cost > $2500, must be presented to an expenditure committee.
Overnight Trucking	Long Haul Motor Freight Movement	18-Wheel Tractor/ Trailers	N/A	Equipment is sold before high maintenance to replacement % is reached. Cyclic repair with replacement in 3-4 years. Time, customer satisfaction, resale value, high mileage usage contribute to this policy.
Safeway Trucking	Short Haul Food Distributor	Large Trucks	Sliding Scale based on age	Individual evaluation - a committee considers market value, service potential, company economics. (12 yr average lifespan).
US Postal Service	Short Distance Deliveries	Motor Vehicles	Table - using age/ mileage & acquisition cost	Regional headquarters grants waivers based on availability of replacement and useful life.

Extracted from reference [14].

3.5. Current Army MEL Procedure.

The item managers at the MSCs are responsible for managing the Army's assets. They fill requisitions, order the acquisition of replacement items, provide disposition instructions for failed equipment, and establish repair programs. The item manager at the MSC initiates any repair action with a supply control study. The following steps outline the process:

a. If the study indicates that additional units are required, a repair PRON is prepared stating how many units are needed from a repair program, the delivery date, and the MEL value. The item manager calculates the MEL at the time that the PRON is prepared by taking a percentage of the item price as found in the Army Master Data File (AMDF) or CCSS. With a 100% MEL, the maximum repair expenditure per item is equal to the item price. In some cases the item manager may state a MEL that is below 100%.

b. The PRON is processed through the MSC and sent through the Depot System Command (DESCOM) to the depot that will be doing the repair.

c. At the time that the PRON is executed, the depot estimated repair cost, called the Unit Maintenance Total Cost (often referred to as Unit Total Cost (UTOT)) is compared to the MEL value.

d. If the UTOT is less than the MEL, repair proceeds.

e. If the UTOT is greater than the MEL value, the depot is not authorized to proceed with the repair program and the depot sends a request for waiver of the MEL (a request to exceed the MEL) through DESCOM to the MSC.

f. If the waiver is denied, the repair program is cancelled, the accumulated assets scheduled for repair are usually sent to disposal, and the National Stock Number (NSN) is reviewed for reclassification to a nonreparable. In practice, very few waivers are denied because by the time the depot is ready to execute the repair program for the PRON and discovers that the MEL will be exceeded, the item manager expects to receive these items from this source and any delay at that stage to procure items may impact readiness. In its audit, the DOD IG stated that up to 98% of the requests for waiver were approved.

g. The item manager can proceed with the repair program in two ways. Either the waiver can be granted, or the item manager can review and update the CURP that was used as the basis for the initial MEL value and, therefore, establish a new MEL value. The CURP update was the usual response to a waiver when the maximum MEL was 65% and is still a common response to a request for waiver.

3.6. Problems With the Current Army Procedure.

a. The current procedure often leads to an erroneous MEL because the AMDF or CCSS price may not be current and because all pertinent acquisition and repair costs are not considered.

b. The current procedure is not in accordance with AR 750-1 [2] which states that the following cost elements should be used in estimating the cost of repair:

(1) Direct Labor.

(2) Direct Materials.

(3) Indirect or Overhead Costs.

(4) Contractual Services.

(5) Shipping and Transportation Costs.

(6) Other Charges (which can be directly identified to the repair task).

c. Because of these problems with the current Army procedure, HQ AMC tasked AMSAA to specifically develop a simple, quantitative, and auditable method for determining MEL.

Chapter 4. APPROACHES CONSIDERED IN DEVELOPING MEL

Three approaches were considered for establishing MEL. The premise in each case was that to be economical, the total cost to repair the PRON items must be lower than the total cost to acquire them new.

a. Modification of LORA Models.

(1) Since many LORA models have been approved for use within AMC and since their objectives are related to that of the MEL, their use in establishing a MEL was considered. To use for MEL calculations, each model required modification by removing cost elements that, after the item has been fielded, have become sunk costs. Each LORA model would have to be used in the single echelon mode; i.e., depot. This approach would not provide a MEL as such but by a comparison of the total acquisition cost and the total repair cost, it would indicate that repair should or should not proceed. If repair was more expensive than acquisition, then the item should be reviewed for reclassification to nonreparable status.

(2) It was assumed that since LORA is required on all items and components prior to fielding, the input cost variables required by the models would be available and only a few of these variables would require modification as a result of more up-to-date information. Some cost variables that had become sunk costs would not have to be considered at all. A further discussion may be found in Appendix B.

(3) This approach was reviewed by MSC personnel and rejected because the LORA models are complex to use and input data is difficult to obtain.

b. Repair Ratio Cost Curves.

(1) When depot repair data is analyzed for each MSC, a relationahip can be found between CURP as stated on the PRON and the UTOT. Regression analysis shows a curvilinear relationship between these two values that is reasonably constant from year to year. From this, another relationship can be established between CURP and the repair ratio (UTOT/CURP) which is in essence the historic maximum MEL. When both the associated acquisition (AAC) and associated repair (ARC) costs are incorporated in the regression equation, the MEL for an item can be obtained.

(2) The relationship between CURP and UTOT can be stated as:

$$UTOT = a + b(CURP) \qquad [1]$$

where a and b are constants.

(3) The relationship between CURP, the repair ratio and maximum MEL is then:

$$UTOT / CURP = MEL = (a / CURP) + b \qquad [2]$$

(4) When the associated acquisition and associated repair costs are incorporated in the above equation, the following results:

$$(UTOT + ARC) / (CURP + AAC) = MEL = (a / (CURP + AAC)) + b \quad [3]$$

(5) This was done for each MSC.

(6) This approach was rejected because of the strong dependence of the generated MEL on historic UTOT and because one generalized MEL predictor curve would not provide sufficient accuracy for all the reparable items managed by an MSC. A MEL for groups of similar items could be developed by grouping of items that have similar characteristics and developing equations and curves for each group--an unnecessary, complex procedure.

c. Algebraic Formula. In this approach an algebraic equation relating all acquisition and all repair costs was developed. The MEL is dependent on the CURP but is strongly influenced by additional costs that are not considered under current MEL procedures. A factor that considers readiness is also included. This approach is simple to use and requires very little data while it provides an optimal MEL for any item. The development of this method is discussed in the next chapter.

Chapter 5. PROPOSED METHOD FOR DETERMINING MEL

5.1. Introduction.

The decision to repair or discard items that have been programmed for a repair action must be based on a comparison of the total cost to repair the items on a unit basis and the total cost to procure the items on a unit basis. Because quantities vary from acquisition to acquisition and PRON to PRON, unit costs are used for comparison purposes. Under current procedures, many of the relevant costs that must be considered in establishing a maximum MEL and factors that impact readiness are ignored.

5.2. Component Cost Elements.

The cost elements that influence the economics of a MEL decision are discussed below.

a. Unit Acquisition Cost. Items are usually acquired by contract in quantities that will meet the Army's needs and that are in Economic Order Quantities (EOQ). The cost to the government for the contracted quantity is the price that the vendor charges the government for the items and usually includes the first destination charges. While a repair program is performed on the number of items specified on the PRON as a group, the costs that are compared are on a unit basis and the MEL decision is based on the average unit cost for the items on a PRON. The contract cost, divided by the quantity of items acquired, is the Current Unit Replacement Price (CURP) found in the CCSS (for representative buys) and in the AMDF (with surcharges added) for all stock funded items. For Procurement Appropriation (PA) items, these sources reflect the price for the item when it was last acquired. For PA items, this price must be updated to current levels using inflation indices if it is more than 12 months old.

b. Unit Acquisition Associated Cost. Associated with the Unit Acquisition Cost are costs that the government incurs to bring about the acquisition and credits that result from salvage of the scrapped or washed out items that are replaced by the acquisition. The components are:

(1) Unit Cost to Acquire. Associated with each acquisition contract is the Army's cost to prepare and supervise the contract. This cost is determined by multiplying the CURP by a percentage found in AR 37-60.

(2) Net Unit Salvage Value. Since the MEL decision is either to repair or to scrap the group of repair candidates represented by the PRON, an acquisition decision means that no items will be repaired and that the items that were accumulated for repair will be scrapped. Each item that is scrapped and replaced has an inherent salvage value (as a minimum, scrap value) that, in the sense of a trade-in, reduces the cost of its acquired replacement. The salvage value is reduced by the cost to perform the salvage on each item, resulting in a net unit salvage value. The Defense Reutilization Marketing Service (DRMS), Battle Creek, Michigan, is a data source. Salvage value is a controversial issue

since the Army does not receive the net salvage proceeds. It was included here because the government does receive some benefit from the disposal program.

c. Unit Repair Associated Cost. The costs associated with a repair action are the non-depot costs for the MSC administration and the transportation of the items to the depot (including costs to package or crate the item and the handling or administration costs at the field level). It consists of:

(1) Unit MSC Administration Cost. This is the cost to the MSC for the paperwork and communication necessary to determine a requirement for a repair action, to establish a PRON for a repair program, and to accumulate items at depot (but not the cost for packaging, handling, and transportation). A percentage of CURP is used in this report though this cost is often stated as a cost per PRON action. Unit cost can be calculated by dividing the total MSC Administration Cost for that PRON by the number of units received at depot for that specific repair program.

(2) Unit Transportation Cost. The unit transportation cost is the average transportation, packaging, and handling cost for all inducted units. Unit cost can be determined by summing the transportation, packaging, and handling costs for all units returned to depot for that repair PRON and by dividing this sum by the total number of units inducted. Averaged worldwide costs for the return of reparables to a CONUS depot can be derived from AR 37-60.

d. Depot Recoverability Factor. To ensure that the required number of items are returned to supply from a repair action, more items must be inducted into the program than will be returned from it. The difference between the number of items inducted and the number of items returned to supply is the number of items which will be washed out. The Unit MSC Administration Cost and the Unit Transportation Cost above reflect the cost per item if all inducted items were repaired and returned to supply. The additional MSC Administration and Transportation cost for the washed out items can be spread over the items recovered from the repair action by a depot recoverability factor. This factor cannot be more than 1.00 (no items are washed out) and can be no lower than 0.00 (all items are washed out). It is equivalent to the Final Recovery Rate in the Maintenance Data Management System (MDMS), or it may be calculated using the formula in equation [4].

$$\text{DEPOT RECOVERABILITY FACTOR} = \frac{\text{NUMBER OF ITEMS REPAIRED}}{\text{NUMBER OF ITEMS REPAIRED} + \text{NUMBER OF ITEMS WASHED OUT}} \qquad [4]$$

e. MEL. The total cost for a depot repair action is the sum of the UTOT and all associated repair costs. UTOT consists of Unit Maintenance Funded Cost (UFUN) charged to the commodity MSC and the free issue repair parts. The equation established a maximum, economical repair cost which is compared to the UTOT. This maximum economical repair cost is the MEL.

f. Equivalence Factor.

(1) An additional cost parameter, the equivalence factor, becomes important after an item has been fielded and especially important after it has been repaired several times. The equivalence factor reflects adverse readiness impacts. The inclusion of this parameter increases the cost to repair an item and, therefore, decreases the MEL. The equivalence factor is the relative worth to the Army of the repaired item as compared to a new, similar or substitute item of equivalent performance. Relative worth is determined by the expected reliability and durability of the repaired versus a new replacement item and the impact on future operation and support costs. Experience has shown that the reliability, and occasionally the capability, of a repaired item is lower than that of a new item. The repair action taken replaces or reconditions the failed component(s) but other components are not reconditioned. These other components may no longer be as reliable as the replacement components resulting in equipment that, while serviceable, is not as reliable as a new item. Also, the repair action itself can degrade other components. For example, some electronic circuit boards can be repaired only two or three times before the reliability (Mean Time Between Failure (MTBF)) has decreased to a point where further repair is no longer economical. Tolerances may be within specifications but the additive effects of repeated repair result in decreased MTBF.

(2) Maintenance engineering can provide an experience based estimate of the equivalence of a repaired item or component compared to a new one. The value of this factor can range from a minimum of 0.01 to a maximum of 1.00 (completely equivalent). When estimating the Equivalence Factor, the following considerations are evaluated:

(a) Expected remaining service life. Most items deteriorate through age and usage, decreasing their effectiveness. An item has an expected service life measured in years, miles, operating hours, or rounds fired. An age/usage factor, as a ratio of age/usage to date to the maximum expected age/usage, can be used to modify the maintenance cost.

(b) Technological and Operational Obsolescence. Technological obsolescence and availability of more operationally and logistically effective replacements must be a consideration in making a repair decision. As the years of service increase, this factor also increases, until an upgrade or replacement becomes cost-effective. Obsolescence is measured as the capability of the existing item compared to that of the next generation for which technology exists.

(c) Potential for Upgrade. If a product improvement is scheduled for an item, a repair prior to and as a separate event from the modification action may be inopportune. As a minimum, the costs associated with the packaging, shipping, and administration of these items would be incurred twice, once for the repair action and once for the upgrade action.

(d) Condition Factor. Inspectors at depot judge the condition of items awaiting repair as being normal, above normal, or below normal in repair requirements. This variation from normal will require an adjustment to the maintenance cost.

5.3. <u>MEL Equations</u>.

a. The basic relationship shown in inequality [5] must be satisfied to economically justify a decision to repair. The left hand side of the inequality represents total repair cost. The right hand side of the inequality represents total acquisition cost.

$$\begin{array}{c}\text{UNIT}\\ \text{REPAIR}\\ \text{COST}\\ \text{(UTOT)}\end{array} + \begin{array}{c}\text{UNIT}\\ \text{REPAIR}\\ \text{ASSOCIATED}\\ \text{COST}\end{array} \leq \begin{array}{c}\text{UNIT}\\ \text{ACQUISITION}\\ \text{COST}\\ \text{(CURP)}\end{array} + \begin{array}{c}\text{UNIT}\\ \text{ACQUISITION}\\ \text{ASSOCIATED}\\ \text{COST}\end{array} \qquad [5]$$

where:

$$\begin{array}{l}\text{UNIT REPAIR}\\ \text{ASSOCIATED}\\ \quad\text{COST}\end{array} = \frac{\left[\begin{array}{l}\text{UNIT MSC}\\ \text{ADMINISTRATION COST}\end{array} + \begin{array}{l}\text{UNIT TRANSPORTATION,}\\ \text{PACKAGING AND HANDLING COST}\end{array}\right]}{\text{DEPOT RECOVERABILITY FACTOR}}$$

and:

$$\begin{array}{l}\text{UNIT ACQUISITION}\\ \text{ASSOCIATED COST}\end{array} = \begin{array}{l}\text{UNIT COST}\\ \text{TO ACQUIRE}\end{array} - \begin{array}{c}\text{UNIT SALVAGE}\\ \text{VALUE}\end{array} + \begin{array}{c}\text{UNIT SALVAGE}\\ \text{COST}\end{array}$$

This inequality [5] can be rearranged to isolate UTOT as shown in inequality [6] below.

$$\text{UTOT} \leq \begin{array}{c}\text{UNIT}\\ \text{ACQUISITION}\\ \text{COST}\\ \text{(CURP}\end{array} + \begin{array}{c}\text{UNIT}\\ \text{ACQUISITION}\\ \text{ASSOCIATED}\\ \text{COST}\end{array} - \begin{array}{c}\text{UNIT}\\ \text{REPAIR}\\ \text{ASSOCIATED}\\ \text{COST}\end{array} \qquad [6]$$

b. In the actual decision process, however, it is the depot's UTOT that is compared against the item manager's MEL. To economically justify repair, inequality [7] must be satisfied.

$$\text{UTOT} \leq \text{MEL} \qquad [7]$$

c. Since the left hand sides of inequalities [6] and [7] are equal, a formula for MEL can be derived in terms of its component parts by equaling the right hand sides of these inequalities. The result is shown as equation [8].

$$\begin{array}{c}\text{UNIT}\\ \text{ACQUISITION}\\ \text{COST}\\ \text{(CURP)}\end{array} + \begin{array}{c}\text{UNIT}\\ \text{ACQUISITION}\\ \text{ASSOCIATED}\\ \text{COST}\end{array} - \begin{array}{c}\text{UNIT}\\ \text{REPAIR}\\ \text{ASSOCIATED}\\ \text{COST}\end{array} = \text{MEL} \qquad [8]$$

d. The cost terms in equation [8] can be resolved into finer cost components and modified to reflect a factor for items brought into the depot for repair but washed out and a factor for readiness and reliability considerations. These refinements are explained below and redefined in equation [9].

$$\text{EQUIVALENCE FACTOR} \left[\begin{array}{c}\text{UNIT} \\ \text{ACQUISITION} \\ \text{COST} \\ \text{(CURP)}\end{array} + \begin{array}{c}\text{UNIT} \\ \text{ACQUISITION} \\ \text{ASSOCIATED} \\ \text{COST}\end{array} \right] - \left[\begin{array}{c}\text{UNIT} \\ \text{REPAIR} \\ \text{ASSOCIATED} \\ \text{COST}\end{array} \right] = \text{MAX MEL} \qquad [9]$$

5.4. Worksheet.

A worksheet for calculating MEL values was developed from equation [9]. This worksheet is shown in Figure 1. New MEL procedures incorporating the use of the worksheet are described in Chapter 6 and Appendix C for MSCs, DESCOM, and depots.

MEL COMPUTATION WORKSHEET

			SUB-TOTALS	TOTALS
	UNIT ACQUISITION COST			
A	Current Unit Replacement Price	$____		
	UNIT ACQUISITION ASSOCIATED COST			
B	Unit Cost to Acquire	$____		
C	Gross Unit Acquisition Cost (A+B)		$____	
D	Unit Salvage Value	$____		
E	Unit Salvage Cost	$____		
F	Net Unit Salvage Value (D-E)		$____	
G	Net Unit Acquisition Cost (C-F)			$____
	UNIT REPAIR ASSOCIATED COSTS			
H	Unit MSC Administration Cost	$____		
I	Unit Trans, Pack, Handl Cost	$____		
J	Depot Recoverability Factor	.____		
K	Unit Repair Associated Cost (H+I)/J			$____

L Equivalence Factor ____.____

M MEL VALUE = ((L) ____.____ x (G)$________) - (K)$________ = $________

N MEL PERCENT = (M)________ / (A)________ = ________%

Figure 1. Example of MEL Computation Worksheet

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Chapter 6. USING THE WORKSHEET

6.1. Discussion of Data Requirements for Completed Worksheet.

A general discussion of the cost factors was given in Chapter 5. The worksheet in Figure 1 may be used to determine a MEL value for a reparable item. An example of a completed worksheet is shown in Figure 2. Cost factors are entered and the indicated operations are performed. When possible, actual costs should be acquired and used. When actual cost data is not available, default values should be used. Sources and default values for the cost factors are summarized in Table 3 and discussed in detail in Appendix D. (Note that several table(s) and figure(s) are consolidated at the end of this chapter for ease of readability.) Each worksheet entry is discussed in the order of its appearance.

a. Current Unit Replacement Price (A). This is the item price from CCSS or the AMDF updated to current year. If the existing PA price is less than 12 months old, no update is necessary.

Example: PA item last procured two years ago at price of $920.

Inflation factor one year ago = 4.2%, two years ago = 4.3%.

$920 x 104.3% = $ 960
$960 x 104.2% = $1000
CURP for calculation = $1000

b. Unit Cost to Acquire (B). The default unit cost is 3% (see Table 3) of the CURP.

Example: $1000.00 x 3% = $30.00

c. Gross Unit Acquisition Cost (C). Actual cost to the Army to acquire one unit represented by the repair PRON.

Example: A + B = C

$1000 + $30.00 = $1030.00

d. Unit Salvage Value (D). Since the default value was used for Net Unit Salvage Value below, the same value ($80.00) is entered here and $0.00 is entered as the Unit Salvage Cost.

e. Unit Salvage Cost (E). Default value used, enter $0.00, see explanation under Unit Salvage Value.

f. Net Unit Salvage Value (F). Default value used, hypothetical item is an electronic circuit board.

Example: 8% of $1000.00 (CURP) = $80.00

MEL COMPUTATION WORKSHEET

			SUB-TOTALS	TOTALS
	UNIT ACQUISITION COST			
A	Current Unit Replacement Price	$1000.00		
	UNIT ACQUISITION ASSOCIATED COST			
B	Unit Cost to Acquire	$ 30.00		
C	Gross Unit Acquisition Cost (A+B)		$1030.00	
D	Unit Salvage Value	$ 80.00		
E	Unit Salvage Cost	$ 0.00		
F	Net Unit Salvage Value (D-E)		$ 80.00	
G	Net Unit Acquisition Cost (C-F)			$ 950.00
	UNIT ASSOCIATED REPAIR COSTS			
H	Unit MSC Administration Cost	$ 30.00		
I	Unit Trans, Pack, Handl Cost	$ 105.00		
J	Depot Recoverability Factor	0.90		
K	Unit Repair Associated Cost (H+I)/J			$ 150.00

L Equivalence Factor 0.90

M MEL VALUE = ((L) 0.90 x (G)$ 950.00)) - (K)$ 150.00 = $ 705.00

N MEL PERCENT = (M)705.00 / (A)1000.00 = 71 %

Figure 2. Example of Completed MEL Computation Worksheet

g. Net Unit Acquisition Cost (G). The net cost to the US government of acquiring one unit represented by the repair PRON.

Example: C - F = G

$1030.00 - $80.00 = $950.00

h. Unit MSC Administration Costs (H). The unit cost to perform the required paperwork on a repair PRON action, 3% of CURP (default value).

Example: 3% of $1000.00 (CURP) = $30.00

i. Unit Transportation, Packaging, and Handling Cost (I). From Figure 3, $105. The derivation of Figure 3 can be found in Appendix D.

j. Depot Recoverability Factor (J). The recoverability factor spreads the cost for all the items inducted over only the repaired items. For example, to repair 100 items, 111 may need to be inducted.

Example: 100 / 111 = 0.90

k. Unit Repair Associated Cost (K). The sum of the Unit MSC Administration Cost and the Unit Transportation Packaging and Handling Cost divided by the Depot Recoverability Factor.

Example: (H + I) / J = K

($30.00 + $105.00) / 0.90 = $150.00

l. Equivalence Factor (L). This factor puts a value on the repaired item as compared to a new item. If this factor is 0.90 then Maintenance Engineering has determined that the repaired item is 90% as reliable/capable/effective as a new item.

m. MEL Value (M). The MEL value is found by combining the terms as shown on the worksheet.

Example: (0.90 x $950.00) - 150.00 = $705.00

n. MEL Percent (N). The MEL percent is found by dividing the MEL value (M) by the CURP (A).

Example: $705.00 / $1000.00 = .705 = 71%

6.2. Data Sources.

Table 3 gives a listing of data sources for the worksheet cost factors.

6.3. Default Values for Worksheet Data.

Various studies and reports were screened for cost variables used in the MEL worksheet to establish default values that could be used when more specific data is not available. Some values for the associated cost variables are available from CCSS. Default values are listed in Table 3. A discussion of source material is found in Appendix D.

TABLE 3. Cost Factor Sources and Default Values

COST FACTOR	SOURCE	DEFAULT VALUES	NOTES
A CURP	CCSS AMDF SB 710-1-1[16]	None. The actual value (inflated if necessary) must be used in all cases.	Update using inflation indices may be necessary for PA items if price is more than 12 months old.
B Unit Cost to Acquire	AR 37-60[1]	Use 3% of CURP.	
D Unit Salvage Value	DRMS*	None. Enter value from Net Unit Salvage Value.	
E Unit Salvage Cost	DRMS*	None. Enter zero.	
F New Unit Salvage Value	DRMS*	For all items except electronic circuit boards use 4% of CURP. For electronic circuit boards use 8% of CURP.	
H Unit MSC Adminis-tration Cost	AR 37-60 [1] CCSS	Use 3% of CURP.	
I Unit Trans-portation, Packaging, & Handling Cost	AR 37-60[1]	None. Use Figure 3	
J Depot Recovera-bility Factor	CCSS (MDMS)*	0.90	
L Equivalence Factor	Maintenance Engineering	0.90	Factor that represents all the items on the PRON.

* DRMS Defense Reutilization Marketing Service
MDMS Maintenance Data Management System

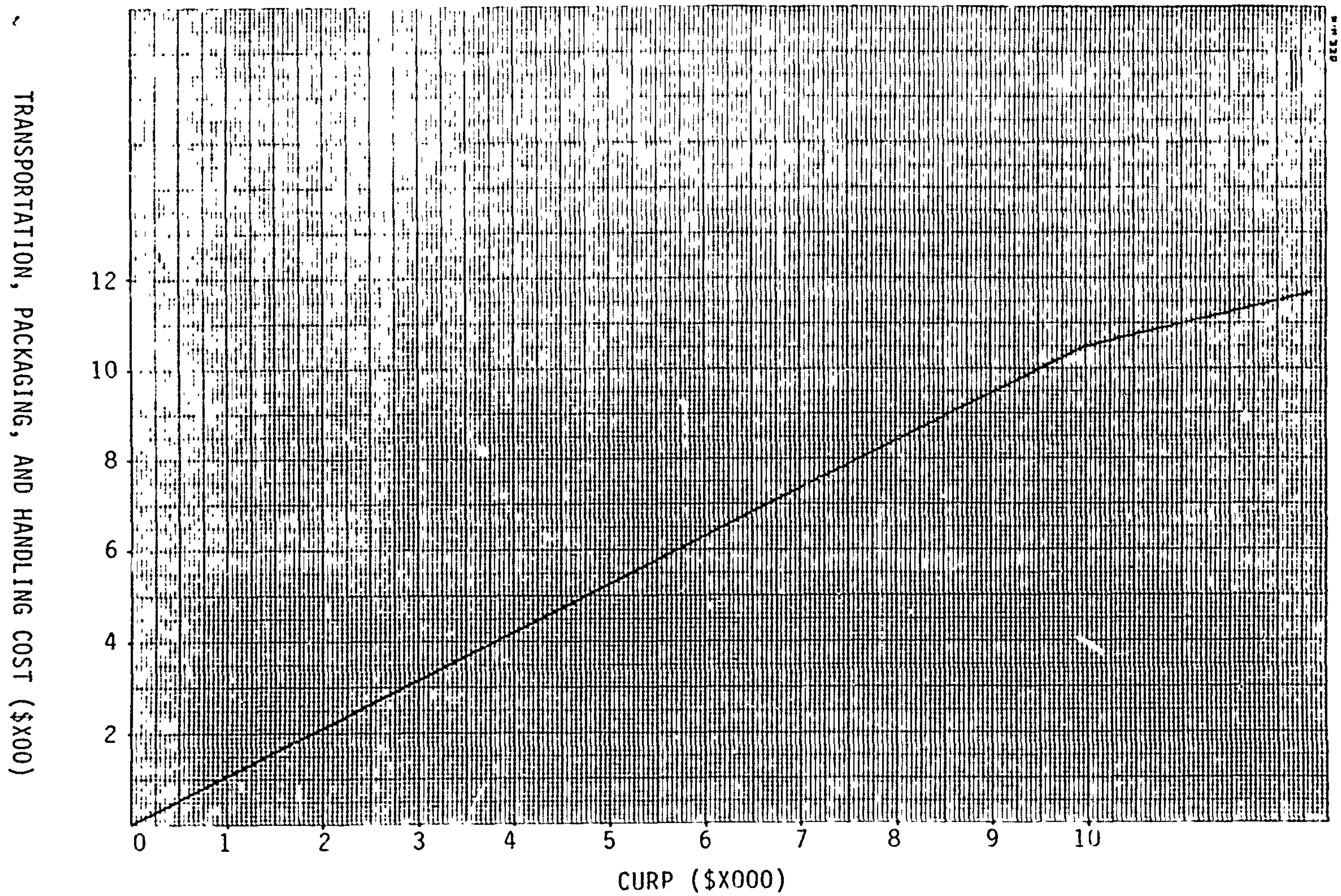


Figure 3. Transportation, Packaging, and Handling Cost Curve $0 to $10000

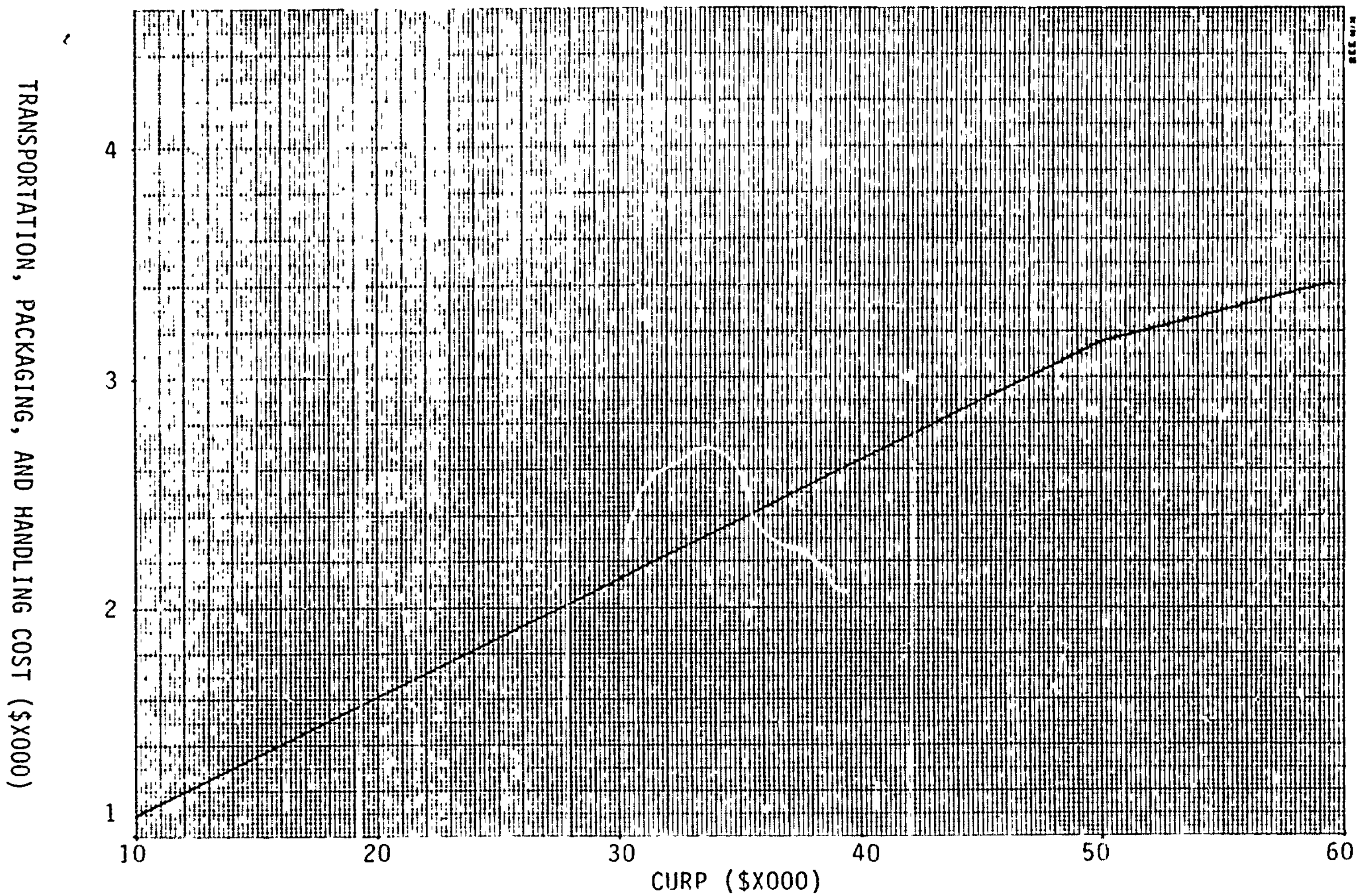
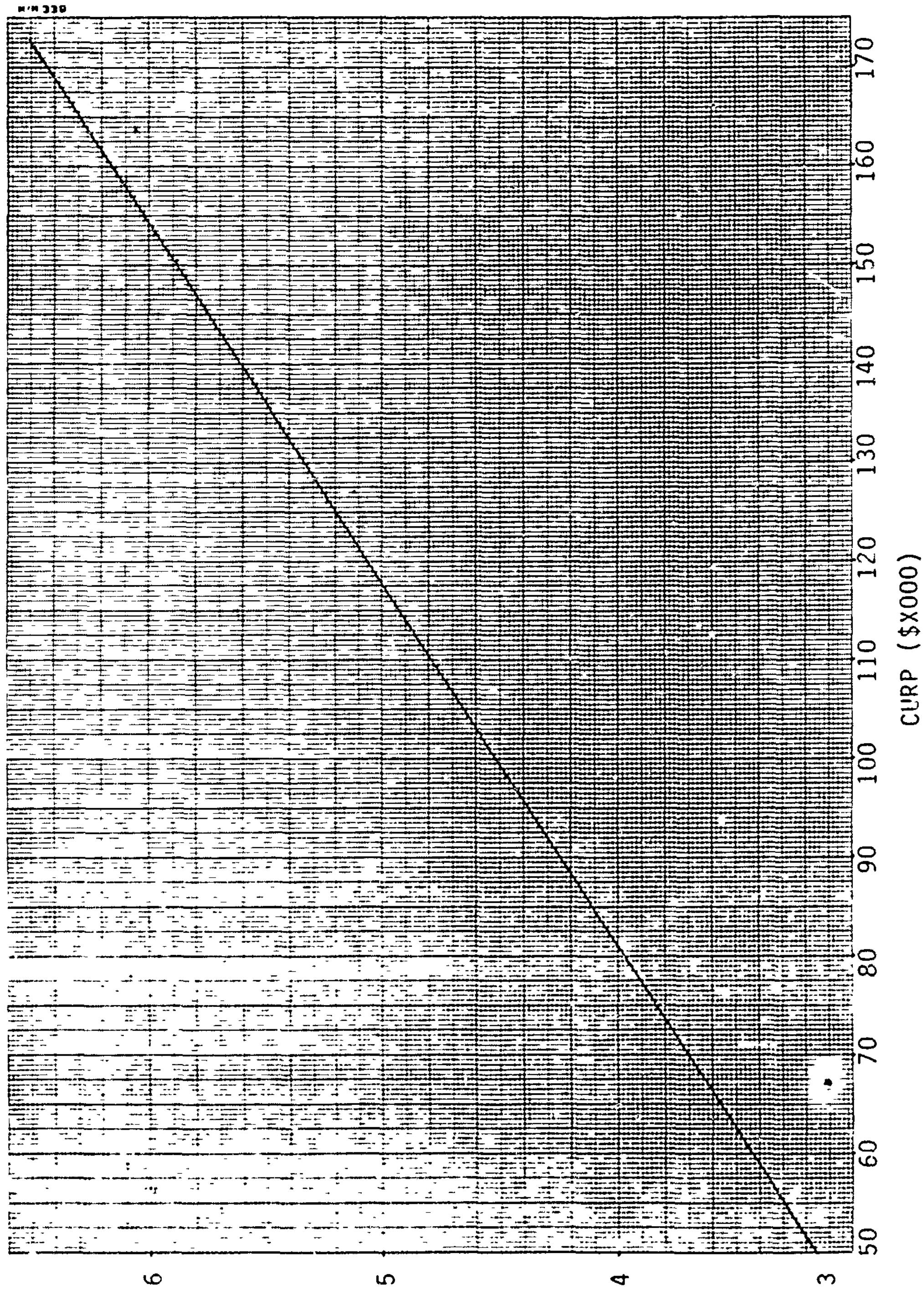


Figure 3. Transportation, Packaging, and Handling Cost Curve (cont) $10000 to $60000



TRANSPORTATION, PACKAGING, AND HANDLING COST ($X000)

Figure 3. Transportation, Packaging, and Handling Cost Curve (cont) $50000 to $175000

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Chapter 7. FINDINGS

a. The present MEL procedure is inadequate because a 100% MEL is arbitrary, the relevant acquisition and repair costs are not included in a MEL determination, and items are repaired that should be replaced.

b. In calculating an optimal MEL for low priced items (CURP < $5000), the associated procurement costs and the associated repair costs must be included.

c. In calculating an optimal MEL for high priced items (CURP > $5000), the associated procurement costs and the associated repair costs become almost insignificant.

d. The variable that has the greatest impact over all CURP ranges is the equivalence factor.

e. Level of Repair Analyses which determine if an item will be classified a reparable or a throwaway are necessary and critical prior to an item or component being fielded. The several LORA models that have been approved for use within AMC, while very powerful, are complex and require data that are often difficult to acquire. Therefore, these analyses have often been performed using estimated data and without the benefit of one of the available models. Post-fielding analyses are mandated so that the earlier findings can be updated from the experience in the field. These are rarely accomplished because of the complexity of the models and the data requirements.

f. The revised procedure for maintenance at depot level will be incorporated in an AMC regulation. The procedure provides a means for updating the CURP on a PRON before the repair program is executed and for exempting some items from a MEL calculation and the possibility of a request for waiver. The depot reparable items that can only be acquired as a result of a depot repair program can be exempted from a MEL thus eliminating the possibility of the generation and processing of a request for waiver.

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Chapter 8. CONCLUSIONS

a. The use of modified LORA models for MEL decisions is not appropriate because of their complexity.

b. In order to determine an optimal MEL for a depot reparable item, it is imperative that the CURP be used and that the costs associated with acquiring and repairing the item be included in the calculation.

c. The method developed in this study for calculating an optimal MEL, for any depot reparable item, provides a simple method that requires little data and can be easily automated and incorporated in CCSS. The worksheet used for the manual calculation provides a record of the data used in the calculation and thus an audit trail. Quick MEL calculations can be made using default values.

d. The revised maintenance procedure avoids the cost of unnecessary requests for waiver and MEL calculations.

e. A MEL of 100% will result in fewer requests for waiver than a MEL of 65%, but it is also more likely to authorize and perpetuate the repair of items that should be sent to disposal.

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Chapter 9. RECOMMENDATIONS

a. The method for calculating optimal MEL for depot reparable items using the MEL Computation Worksheet should be implemented throughout AMC.

b. A work group should be convened to prepare a System Change Request to CCSS to incorporate data required for the MEL calculation in CCSS and to provide a means of calculating and storing the MEL in the system.

c. Work should be initiated to establish criteria for determining equivalence factors for depot reparable items.

d. The revised maintenance procedure described in this report should be implemented throughout AMC. The procedure exempts from the MEL process items that cannot be acquired and that require a review of PRON data prior to the execution year.

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APPENDIX A

REFERENCES

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REFERENCES

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APPENDIX B

LEVEL OF REPAIR ANALYSIS

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LEVEL OF REPAIR ANALYSIS

1. MEL decisions supplement other repair/discard decisions that are made during the early development stages of an item or its parent item. The class of such decisions is called Level of Repair Analysis (LORA).

2. Level of Repair Analysis is required during the development phase for all items or components of Army equipment. These analyses determine if, at failure, it is more cost effective to repair an item (classify it reparable) or to dispose of it and procure replacements (classify it consumable). For reparable items, the analyses also indicate at which echelon the item should be repaired.

3. These models are used early in the development phase to provide a basis for maintenance planning and should be constantly reviewed and modified after the item has been fielded. AMC-R 700-27 states:

> "Initially, during concept exploration phase, level of repair/discard determination may be tentatively assigned based upon engineering studies, evaluations, and historic data. Later, in the Demonstration and Validation Phase, selected items will be subjected to an initial LORA to isolate items which should clearly be designed for discard from those that may be designed for repair. In the Full Scale Development Phase, detailed LORA evaluations (considering both the economics and non-economics of the repair level/discard alternatives) will be accomplished. In the Production and Deployment Phase, a LORA will be used for update purposes to adjust LORA decisions based on field experience and LORA evaluations on ECPs and PIPs."

4. To use a LORA model, all cost variables associated with acquiring and repairing a new item are considered. These include the logistics costs of keeping spares stocked, personnel trained, and manuals written. In some models, up to 250 different cost variables can be used.

5. Unfortunately, repair/discard and level of repair decisions are difficult and costly to change once they have been implemented because test equipment has been acquired, manuals prepared, and spares have been stocked. As a result, the Army maintenance program may not be optimal; but, because of the investment made, it may be too costly to change. Reevaluating earlier decisions with a complete LORA is counterproductive but performing post-fielding LORAs for a single echelon (depot) is recommended.

6. Approved LORA Models. Twelve different models have been developed for these analyses within AMC. Eight of these have been approved for use and are listed in AMC-R 700-27 (see listing below). MRSA has performed technical reviews of these models and has published reports (Logistics Support Analysis Techniques (LSAT)) of the reviews.

a. LORA Models for System/End Item Analysis.

(1) Optimum Supply and Maintenance Model (OSAMM).

(2) Logistics Analysis Model (LOGAM).

(3) Network Repair Level Analysis (NRLA) Model.

(4) MIL-STD-1390B.

b. LORA Models for Item Analysis.

(1) Optimum Repair Level Analysis (ORLA), MICOM version.

(2) Item Repair Level Analysis (IRLA).

c. LORA Models for Specific Aspects of Repair Analysis.

(1) Repair Versus Discard Model (PALMAN).

(2) Kasian Test Program Set Model (TPS Kasian).

7. MEL - LORA Comparison.

a. The LORA and MEL repair/discard decisions are similar in that both perform a break-even cost analysis which results in an item being either repaired or discarded, but there are also differences in their usage.

b. LORA repair/discard decisions are made for an NSN throughout the development phase of the item (or of the parent item if the NSN is a component or part), based on the best available data, and result in the classification of an item (NSN) as reparable or as non-reparable. The determination is based on whichever alternative is the more cost-effective to the Army.

c. The MEL decision is made for a batch of like items (classified as reparable by LORA), which have or will be accumulated at depot and are scheduled for repair under one Procurement Request Order Number (PRON). Estimated repair cost for this batch of like items is based on historic repair costs and on an inspection of the batch on arrival at depot. The purpose that the MEL serves is to bring to the item manager's attention any batches of items that may be abnormally costly to repair.

APPENDIX C

NEW MEL PROCEDURE

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NEW MEL PROCEDURE

1. MSC Procedure.

a. The following procedure was developed for use by MSC personnel and will be included in an AMC Regulation 750-XX. This procedure will be used to calculate a MEL value for inclusion on the PRON record. Because a PRON may be established as much as five years prior to its execution, the MEL must be recomputed each time repair and acquisition cost data is updated in the PRON record. A fully automated program that will extract cost data from CCSS and perform the calculations to determine the MEL, given the NSN of an item, will be developed in the future.

b. Repair programs can be scheduled several years into the future. During this period the current unit replacement price of the item and consequently the MEL is not updated through depot costs change annually. MSCs should screen their projected workload annually and recalculate the MEL value using the MEL worksheet.

c. Under some circumstances, for example when an item cannot be acquired in any other way, it may be necessary for repair to proceed even though the repair cost is expected to exceed the acquisition cost. When this occurs, the reasons will be documented and a MEL value sufficient to permit the repair will be included on the PRON.

d. Items should be exempted from MEL when they cannot be procured in time to meet a readiness requirement or when repair is the only source of supply. The PRON should be annotated with a statement that it is exempt to preclude request for waiver. If no replacement is available from any source, the item will be put on an exemption list and repair will proceed as scheduled. If the condition is temporary, a one-time waiver to MEL will be granted and the item will be reclassified for field repair and dispo... Exemptions will be documented and the reasons stated.

e. When the depot repair cost for an item with a continuous depot repair program is less than 75 percent of the computed MEL for two consecutive years, it is not necessary to recompute the MEL on an annual basis. However, when the automated computational program is implemented, annual recomputation should be made.

f. Upon computation of MEL, reevaluation for continued depot repair eligibility should be made if:

(1) Budget year and out year repair cost is $\geq$ 90% of MEL.

(2) Target year (one year prior to execution year) repair cost is $\geq$ 95% MEL.

(3) Prior to start of execution year repair cost is $\geq$ 100% of MEL.

(4) If budget and target year costs exceed the reevaluation threshold, historical trends of repair and acquisition costs for the item, or similar

items, are to be examined to determine if MEL might be reached or exceeded by start of the Execution Year. If there is a positive trend towards exceeding MEL, action must be initiated to reclassify the item for repair and/or disposal at field level and to program acquisition to make up for shortfall resulting from lack of a depot repair program. If there is no alternative source for replacements, and a source cannot be qualified in a reasonable period before phaseout, the item may be exempted from future consideration of MEL and continue to be repaired in depots.

(5) The asset position must be examined before a decision is made to proceed with the work when final adjustments to depot repair costs just prior to the start of execution year or entry of a new PRON during the execution year shows that total repair costs will exceed the MEL. If sufficient assets to meet anticipated demands during the year cannot be obtained, a one-time waiver may be granted to proceed with the repair. Concurrently, action must be initiated to increase acquisition and to reclassify the item for field level repair and disposal. If there is no possible source for acquisition, the item may be exempted from future MEL control.

(6) Other factors which may enter into considerations for granting waivers or exempting items from MEL include:

(a) Remaining years of requirement.

(b) Unavailability of qualified vendors and the time and cost to qualify vendors.

(c) Anticipated low demands which preclude acquisution in economic order quantities with resultant higher than posted acquisition cost.

(d) Lack of acquisition funds.

2. DESCOM Procedure. For any PRON where the final depot calculated repair cost exceeds the MEL value and the item is not exempt, the depot will transmit a request for waiver through DESCOM to the MSC in accordance with DARCOM (AMC) Regulation 750-28 [4]. If the waiver is not granted, the items scheduled for repair will be disposed of as directed by the item manager.

APPENDIX D

SOURCES FOR COST VARIABLES

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SOURCES FOR COST VARIABLES

The sources for the variables used in the MEL worksheet are listed below with the values that were given by them.

a. Unit Cost to Acquire. AR 36-60 [1] provides a value of 3% of CURP for contract administration. The DOD proponent for this regulation approved the use of this percentage for MEL calculations.

b. Net Unit Salvage Value. US Army Logistics Management Center (ALMC).

(1) Net salvage value of usable items (sold at public auction) 4% to 4.5% of CURP.

(2) Net salvage value of electronic circuit boards, $8 per pound weight of board (salvage of precious metals only, tied to market value of gold and silver).

c. Unit MSC Administration Cost. AR 37-60 [1] provides for an administration cost of 3% of CURP. The DOD proponent for this regulation approved the use of this percentage for MEL calculations.

d. Unit Transportation, Packaging, and Handling Cost. Costs as a percent of CURP are provided for Foreign Military Sales (FMS) in AR 37-60 [1]. The DOD proponent for this regulation approved the use of the transportation, packaging, and handling cost percentages for MEL calculations.

(1) Costs are separated into those for transportation and those for packaging or crating the items and handling or field administration. The two must be added to get the total cost for moving an item from the origin to the destination.

(2) The regulation provides the following percentages for transportation (packaging and handling cost below must be added to the transportation cost). For a CURP between $1.00 and $10,000.00 -

Inland origin to inland destination, CONUS	3.75% of CURP
Inland origin Europe to inland destination, CONUS	14.25% of CURP
Inland origin Korea to inland destination, CONUS	16.25% of CURP

For CURP over $10,000.00, the rate is as above for the first $10,000 of CURP plus 25% of the above rate for the amount of CURP over $10,000.

NOTE: Costs from Latin America and Mediterranean Ports are the same as for Europe. Costs from Newfoundland, Labrador, Thule, Iceland, South America (East and West Coasts), Far East, African Ports (other than Mediterranean), and Near East are the same as for Korea.

(3) Packaging and handling costs are the same irrespective of origin or destination. For items with a CURP between $1.00 and $50,000.00 the rate is

3.5% of CURP. For items with a CURP over $50,000.00, the rate is 3.5% of the CURP for the first $50,000 ($1750.00) plus 1.00% of the CURP amount over $50,000.

(4) The items assembled at depot for a repair program are all rarely from the same origin, necessitating a determination of origin and the numbers of items from each origin and then applying the three rates above for transportation. To simplify the calculation for automation, the three rates were combined into one rate that would provide a transportation cost irrespective of the origin. The Special Development and Analysis Division of the USAMC Logistics Control Activity (LCA) [Presidio of SanFrancisco] was contacted for the percentage of materiel returns requisitions from the three origins above. LCA provided the following data:

From Korea	3.0%		
From Europe	26.5%		
From CONUS	68.3%	=	100%
Other oirigins	2.2%		

When other origins are omitted, the percentages become:

From Korea	3.068%		
From Europe	27.096%	=	100%
From CONUS	69.836%		

The combined, weighted rate was:

Rate from Korea = 0.03068 x 16.25 = 0.4985
Rate from Europe = 0.27096 x 14.25 = 3.8612
Rate from CONUS = 0.69836 x 3.75 = 2.6189
6.9785%

This rate (6.9785 x CURP) was applied to an item CURP between $1.00 and $10,000. For an item CURP greater than $10,000 the rate was calculated as ([(CURP - 10000) x 1.7446%] + [10000 x 6.9785%]). Then the packaging and handling cost was added as stated above.

(5) Calculation of combined transportation and packaging and handling costs:

(a) Cost for CURP between $1.00 and $10000.00

Transportation Cost = .069785 x CURP
Packaging/Handling = .035 x CURP
= .104785 x CURP

(b) Cost for CURP between $10001.00 and $50000.00

Transportation Cost = ($10000.00 x .069785) + (CURP - $10000.00) x (.069785 / 4)

= 697.85 + (CURP - 10000) x .01744625
= 697.85 + .01744625 x CURP - 174.4625

Packaging/Handling = .035 x CURP

TOTAL = 697.85 + (.05244625) x CURP - 174.4625
= 523.3875 + (.05244625) x CURP

(c) Cost for CURP greater than $50000.00

Transportation Cost = ($10000.00 x .069785) + (CURP - $10000.00) x (.069785 / 4)

= 523.3875 + .01744625 x CURP

Packaging/Handling = $1750 + (CURP - $50000) x .01
= 1250 + (.01 x CURP)

TOTAL = 1773.3875 + .02744625 x CURP

(6) The transportation, packaging, and handling cost for all points of origin may be read from the graph in Figure 8 of the main report.

e. Depot Recoverability Factor. Washout rate, (attrition factor) 10%, therefore a factor of 90% recovery is used (6, 13).

f. Equivalence Factor. 90% survey of MSC personnel.

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